



TCM 2430 – Construction Safety

Week 8 – Protection against Electrocution & Caught-in/between



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Reminder: Fatal Four

OSHA FATAL FOUR HAZARDS

4,674 private sector worker fatalities occurred in 2017

That means **1 out of every 5** worker deaths was construction-related

971

or **20.7%** were in construction

The Fatal Four were responsible for **59.9%** of the construction worker deaths in 2017

Eliminating the Fatal Four would save **582** workers' lives every year.



Falls 39.2%

The leading cause of death among construction workers

- Ladders
- Scaffolding
- Floor holes may contribute to a worker's fatal fall.
- Ledges
- Roofing
- Cranes
- Wall opening



Electrocutions 7.3%

Electrocution can result from contact with overhead power lines, contact with energized sources such as damaged wires, and improper use of extension cords.



Struck-by Object 8.2%

Struck-by injuries occur when a worker is hit or injured by an object, tool, equipment, or material. They are categorized by:

- Flying object
- Falling object
- Swinging object
- Rolling object



Caught-In/Between 5.1%

Ladders, ledges, cranes, scaffolding, roofing, wall opening, & floor holes may contribute to a worker's fatal fall.

Caught-in or a caught-between occur when a worker is caught, crushed, squeezed, pinched, or compressed between two or more objects.



Pietras Saracino
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Attorneys at Law



Fatal Fours: Electrocution

What do professionals say about electrocution?

Almost every week we face an accident of electrician.

It takes very little current flow to cause harm to a person who comes in direct contact with an electrical circuit.

There is a significant risk of fires due to electrical malfunctions.

Unserious electrocution can cause a worker to fall/slip and lead to serious injuries.

It's essential for everyone on the job site to be vigilant and cautious when working near electrical systems or equipment.

Relying on your experience when dealing with electricity can be misleading.



Who can be exposed to electrocution on a construction job site?

(slide 1 of 2)



Electricians	Electricians are highly trained professionals responsible for installing, maintaining, and repairing electrical systems on construction sites. They are particularly at risk due to their close proximity to live electrical circuits.
Construction workers	Many construction workers may come into contact with electrical systems or equipment as part of their job, especially if they are involved in activities like wiring, drilling, or digging near buried electrical lines.
Equipment operators	Operators of heavy machinery and construction equipment, such as cranes, backhoes, and excavators, can be exposed to electrocution hazards if their equipment accidentally makes contact with overhead power lines or buried electrical cables.
Plumbers and pipefitters	These tradespeople may need to work in areas where electrical systems are present, such as when installing water heaters, pumps, or other equipment that interacts with electricity.
HVAC technicians	Heating, ventilation, and air conditioning technicians often work with electrical components in HVAC systems, which can pose a risk if proper safety precautions are not taken.

Who can be exposed to electrocution on a construction job site?

(slide2 of 2)



Inspectors and supervisors

Construction site inspectors and supervisors may need to be present near electrical work to ensure that safety procedures are followed. They should also be aware of the risks associated with electrical hazards.

General laborers

Even general laborers on construction sites can be exposed to electrocution hazards if they are working in areas where electrical systems are present or if they come into contact with electrical tools and equipment.

Engineers and designers

Engineers and designers involved in the planning and layout of electrical systems on construction projects need to be aware of potential electrocution hazards and ensure that safety measures are integrated into the design.

Visitors and bystanders

Visitors, including clients, family members, and other non-construction personnel, can also be at risk if they enter construction zones without proper awareness of electrical hazards and safety precautions.

Is low voltage safe?

Low voltage does not mean that there is a low hazard of electrical shock. The severity of the shock depends on:

- The path of current through the body
- The amount of current flowing through the body (Ampere)
- The duration of the shocking current through the body



What are the examples of direct electrical injuries?

- Electrocution (death due to electrical shock)
- Electrical shock and related symptoms resulting from the shock (e.g., tissue damage, neurological disorders, muscle contractions which can cause falls and injuries, etc.)
- Burns
- Arc flash/blast (usually resulting in burns, concussion injuries, etc.)



Video

2 Minute Toolbox

Talk: Arc Flash

Injuries

https://www.youtube.com/watch?v=UOUSjfsOveA&t=22s&ab_channel=eSafety



Click here in full screen mode to open the video link

What are the examples of indirect electrical injuries?

- Electric shocks may also cause indirect injuries. Workers on ladders and in elevated areas that encounter shocks can slip, resulting in severe injury or death.

The following are considered to be indirect electrical injuries:

- Falls
- Back injuries
- Cuts to the hands



Video

Preventing electrical hazards and electrocutions

Watch from 1:29

- <https://youtu.be/sA6NGndnTIM?si=Y3RF90h6JfvwHiW7&t=82>



<https://youtu.be/sA6NGndnTIM?si=Y3RF90h6JfvwHiW7&t=82>

What are some examples of electrical hazards?

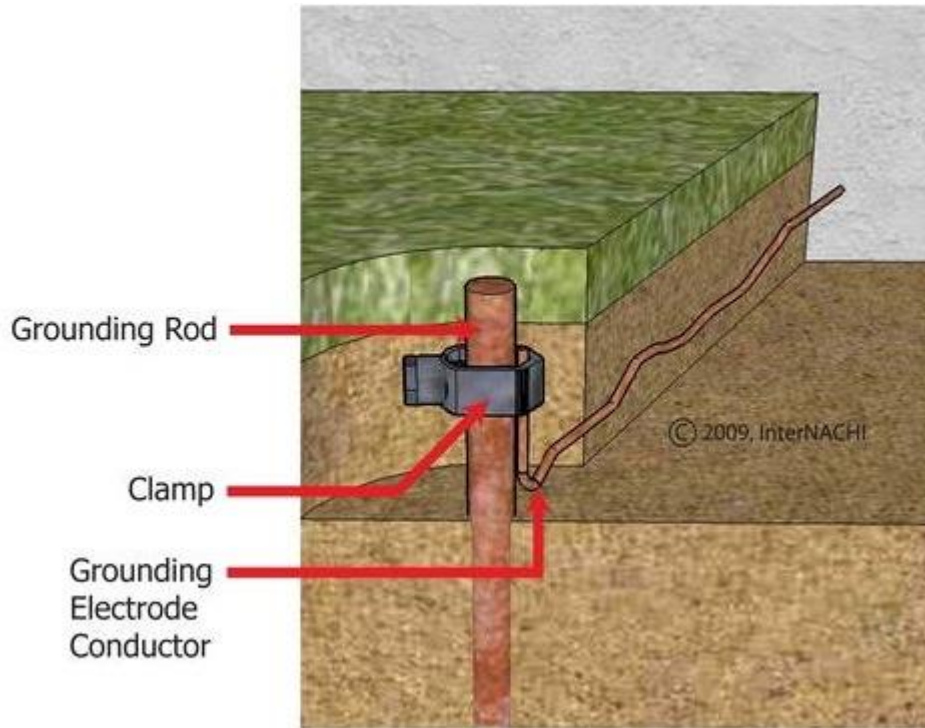
(Slide 1 of 2)

Contact with live electrical wires	• Accidental contact with live electrical wires, such as overhead power lines or exposed wiring, can lead to electrocution.
Overhead power lines	• Construction equipment, like cranes and scaffolding, can come into contact with overhead power lines, posing a risk of electrocution if not properly managed.
Inadequate grounding	• Electrical equipment and tools should be properly grounded to prevent electrical shocks. Failure to do so can result in electrical hazards.
Wet or damp conditions	• Water can conduct electricity, so working with electrical equipment in wet or damp conditions increases the risk of electrical shock.
Damaged or frayed cables and cords	• Worn or damaged electrical cables and extension cords can expose live wires, leading to electrical shocks or fires.
Inadequate electrical insulation	• Electrical equipment and wiring should be adequately insulated to prevent contact with live parts.
Lack of lockout/tagout procedures	• Failure to de-energize and lockout/tagout electrical systems before maintenance or repairs can lead to unexpected energization and electrical accidents.
Unsafe use of extension cords	• Overloading extension cords, using damaged cords, or using cords not rated for the intended purpose can result in electrical hazards.

Overhead power lines in construction

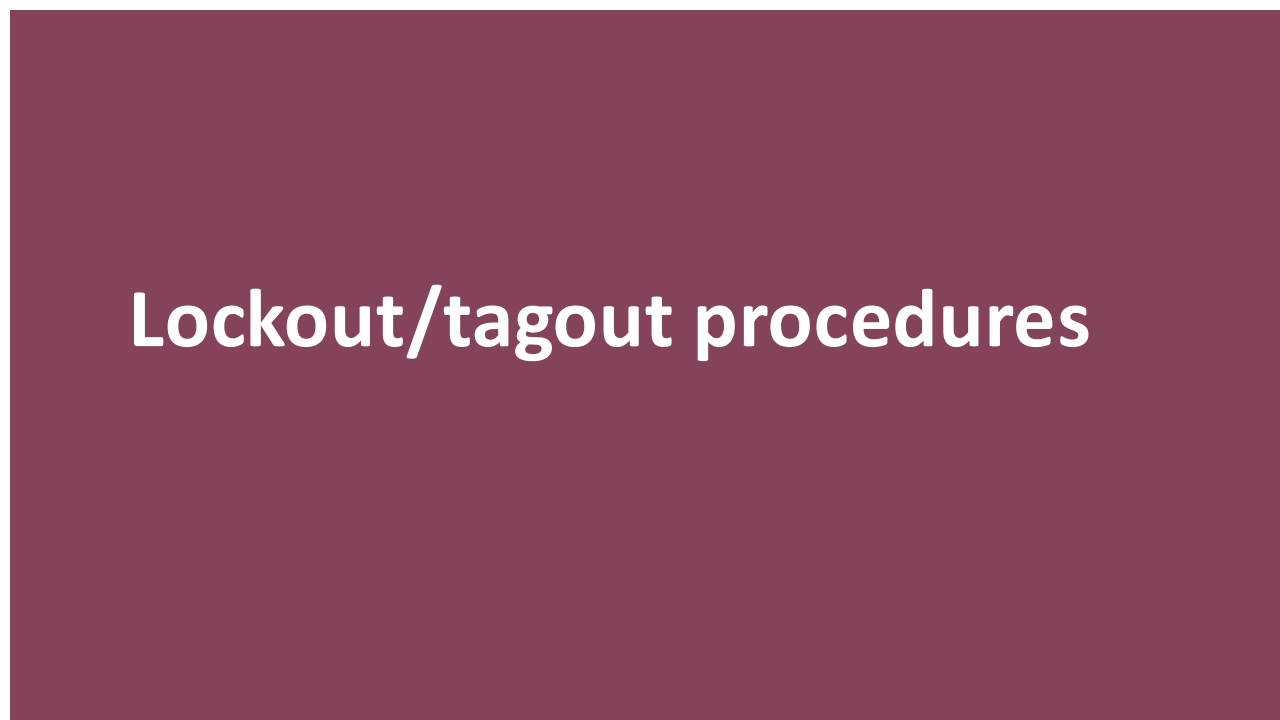


Grounding



https://www.youtube.com/watch?v=C0iOzmJKOg8&ab_channel=TheEngineeringMindset





Lockout/tagout procedures



Unsafe use of extension cords

What are some examples of electrical hazards?

(Slide 2 of 2)

Poorly maintained electrical equipment	• Neglected or poorly maintained electrical tools and equipment may develop faults that increase the risk of electrical accidents.
Confined spaces	• Electrical hazards can be amplified when working in confined spaces where it's challenging to avoid contact with live wires or electrical components.
Inadequate training and supervision	• Workers who are not properly trained or supervised may not be aware of electrical hazards or how to safely work with electrical equipment.
Lack of personal protective equipment (PPE)	• Failure to use appropriate PPE, such as insulated gloves, safety goggles, and non-conductive footwear, can increase the risk of electrical injury.
Overloading circuits	• Plugging too many devices or tools into a single circuit can overload it, leading to overheating and potentially causing electrical fires.
Inadequate signage and warnings	• Failing to mark electrical hazards and provide clear warnings can lead to unsuspecting individuals entering hazardous areas.
Improper use of power tools	• Using power tools near water sources or without proper grounding can create electrical hazards.



Electrocution while
working in confined spaces



YouTube

Click here in full screen mode to open the video link

Video Electrical hazards

- https://www.youtube.com/watch?v=AOgkxPmSYJk&ab_channel=IMCA



What should be controlled to avoid electrical hazards?

(What are the root causes of electrical hazard)

Unsafe equipment
and/or installation

Unsafe workplace
environments

Unsafe work
practices

Video

Electrical Hazards and Emergency Situations

- https://www.youtube.com/watch?v=OEtSLDZTDcA&ab_channel=HAZWOPER-OSHATraining



**Head protection**

Falling or flying objects, overhead objects

**Eye protection**

Blowing dust or particles, metal shavings, acids or caustic liquids, welding light

**Hearing protection**

Loud tools and machinery, poorly maintained equipment

**High-visibility hat, vest, pants**

Errant vehicles, distracted drivers

**Chaps pants**

Chainsaws

**Hand protection**

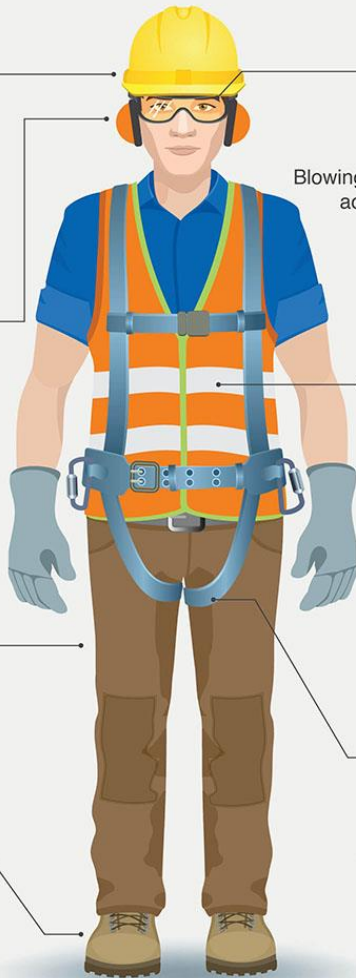
Sharp or hot objects, chemicals, biological or electrical hazards

**Foot protection**

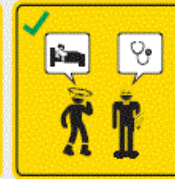
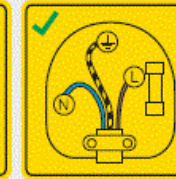
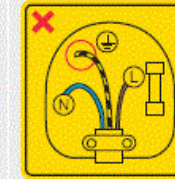
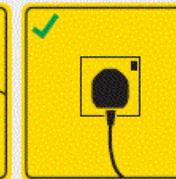
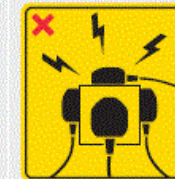
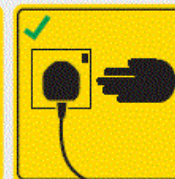
Falling or rolling objects, sharp or heavy objects, wet and slippery surfaces, uneven surfaces, hot surfaces, electrical hazards

**Harness lanyard**

Working more than 6 feet or more above a lower level

**LOOK. THINK. DO.**

Look out for danger. Think of how you can protect yourself. Do your work safely.

6 Basic Workplace Safety and Health (WSH) Rules for Use of Electrical EquipmentOverloading power points, improper earthing and wet surroundings can cause serious injuries and even death to workers. **Every year, 2 workers die and 23 workers are injured from exposure to electric current.** Do your risk assessment before starting work.**Report to your supervisor if you feel unwell.****Ensure correct wiring and proper earthing (⊕).*****Make sure equipment is in good condition before use.****Do not overload power sockets.****Dry your hands before touching equipment.****Use the right personal protective equipment.**Learn more from Energy Market Authority's Guide on Electrical Safety at <http://elise.ema.gov.sg>.

*L: live wire, N: neutral wire, ⊕: earth wire

Sponsored by

**Prevent all injuries.**
*Go home safe and healthy.***VISION ZERO**



Fatal Fours: Caught-in/between

What are caught-in/between accidents on a construction site?

- Accidents that involve workers or objects getting caught, crushed, or trapped between two or more objects or surfaces.

Some examples include:

Trench or
excavation
collapses

Machinery
accidents

Equipment
rollovers

Collapsing
materials or
structures

Pinned or
squeezed
between objects

Confined spaces



How can I prevent Trench or excavation collapses? *(slide 1 of 2)*

Assign a Competent Person

Designate a competent person on-site with training and experience in trenching and excavation safety. Empower them to assess the work area, make safety decisions, and enforce safety measures.

Utilize Trench Protective Systems

Implement appropriate trench protective systems to buttress the sides of the excavation and thwart collapses. Employ three primary types of trench protective systems:

- 1.Slope the Trench:** Angle the trench walls away from the excavation at a safe slope ratio, adjusting it based on soil conditions.
- 2.Shore the Trench:** Use engineered shoring systems, such as hydraulic or mechanical shoring, designed to withstand soil pressure and provide trench wall support.
- 3.Shield the Trench:** Install trench boxes or shields, creating a protective barrier between workers and the trench walls.

Conduct Soil Analysis

Arrange for a soil analysis by a geotechnical engineer to ascertain soil type and stability. This analysis guides the selection of the appropriate protective system and sloping angles.

Establish Safe Access and Egress

Ensure safe means of entry and exit from the trench, such as ladders or ramps, placed no more than 25 feet apart.

How can I prevent trench or excavation collapses? *(slide 2 of 2)*

Implement Benching

If benching is chosen instead of sloping, construct horizontal steps within the trench walls to reduce collapse risk.

Manage Water

Address groundwater and surface water issues that might weaken trench walls. Employ well-point systems, sump pumps, or dewatering techniques as necessary.

Keep Spoil Piles Clear

Maintain spoil piles and equipment at least 2 feet away from the trench edge to avoid additional pressure on the walls.

Perform Inspections

Conduct daily trench inspections before work commencement and after significant weather events or soil condition changes. Vigilantly look for signs of instability, including cracking, bulging, or sloughing.

Equip Workers

Ensure workers within the trench wear proper protective gear, including hard hats, high-visibility vests, and appropriate footwear.

Establish Safety Barriers

Erect barriers or barricades around the excavation site to prevent unauthorized entry and to deter non-essential personnel from approaching the hazard area.

Video

Excavation and Trenching: Safe Work Practices

- https://www.youtube.com/watch?v=ahv8bcYOMMQ&ab_channel=HAZWOPER-OSHATraining





Trench Safety Tips Can Save a Life



Trench collapses cause fatalities and injuries.

It only takes a second for a trench to collapse. Take the following precautions to protect workers in trenches.

Keep rocks, soil, materials and equipment **away** from the edge of the trench.

Check with the competent person **before entering a trench:**

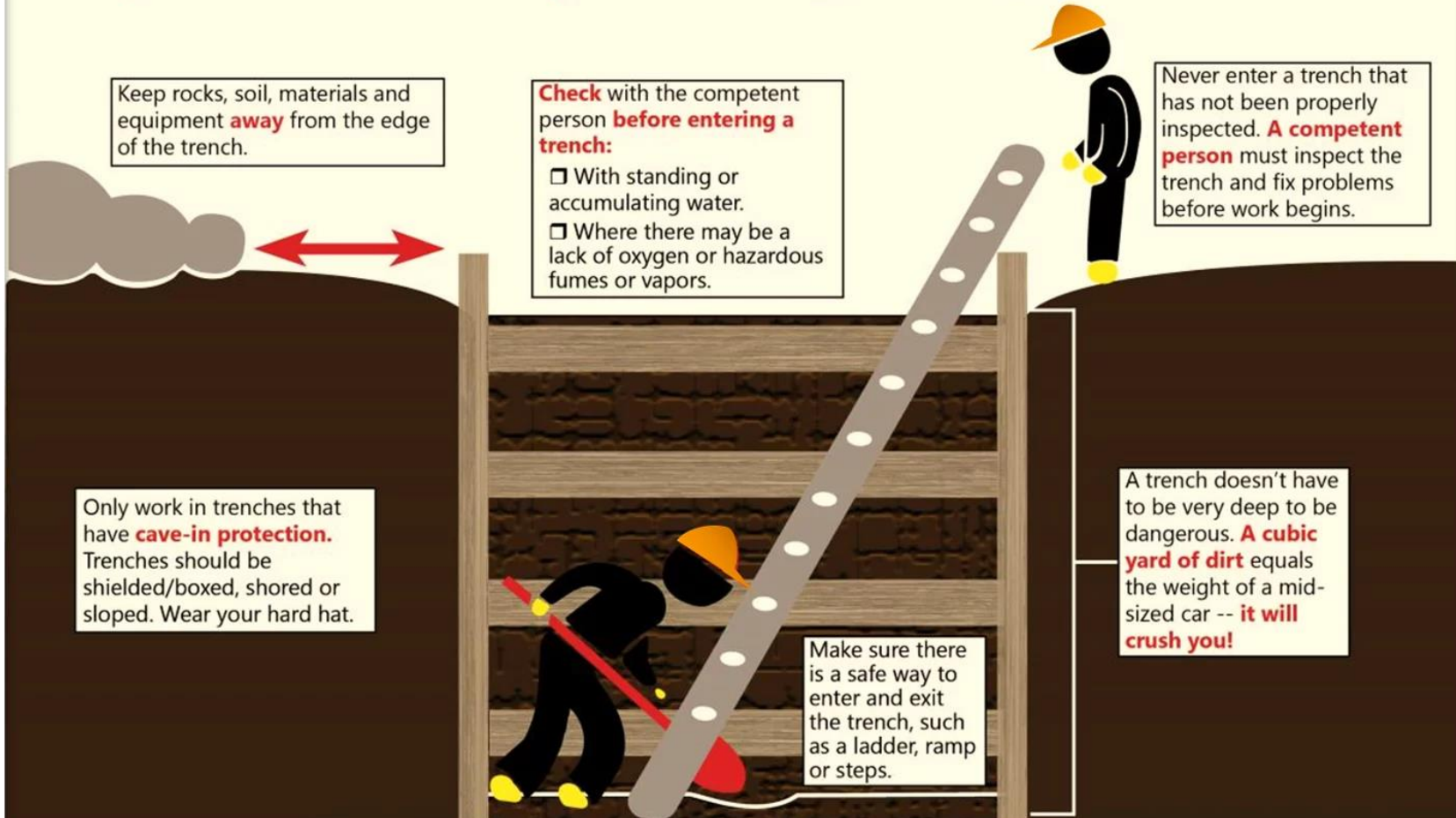
- ☐ With standing or accumulating water.
- ☐ Where there may be a lack of oxygen or hazardous fumes or vapors.

Never enter a trench that has not been properly inspected. **A competent person** must inspect the trench and fix problems before work begins.

Only work in trenches that have **cave-in protection**. Trenches should be shielded/boxed, shored or sloped. Wear your hard hat.

Make sure there is a safe way to enter and exit the trench, such as a ladder, ramp or steps.

A trench doesn't have to be very deep to be dangerous. **A cubic yard of dirt** equals the weight of a mid-sized car -- **it will crush you!**



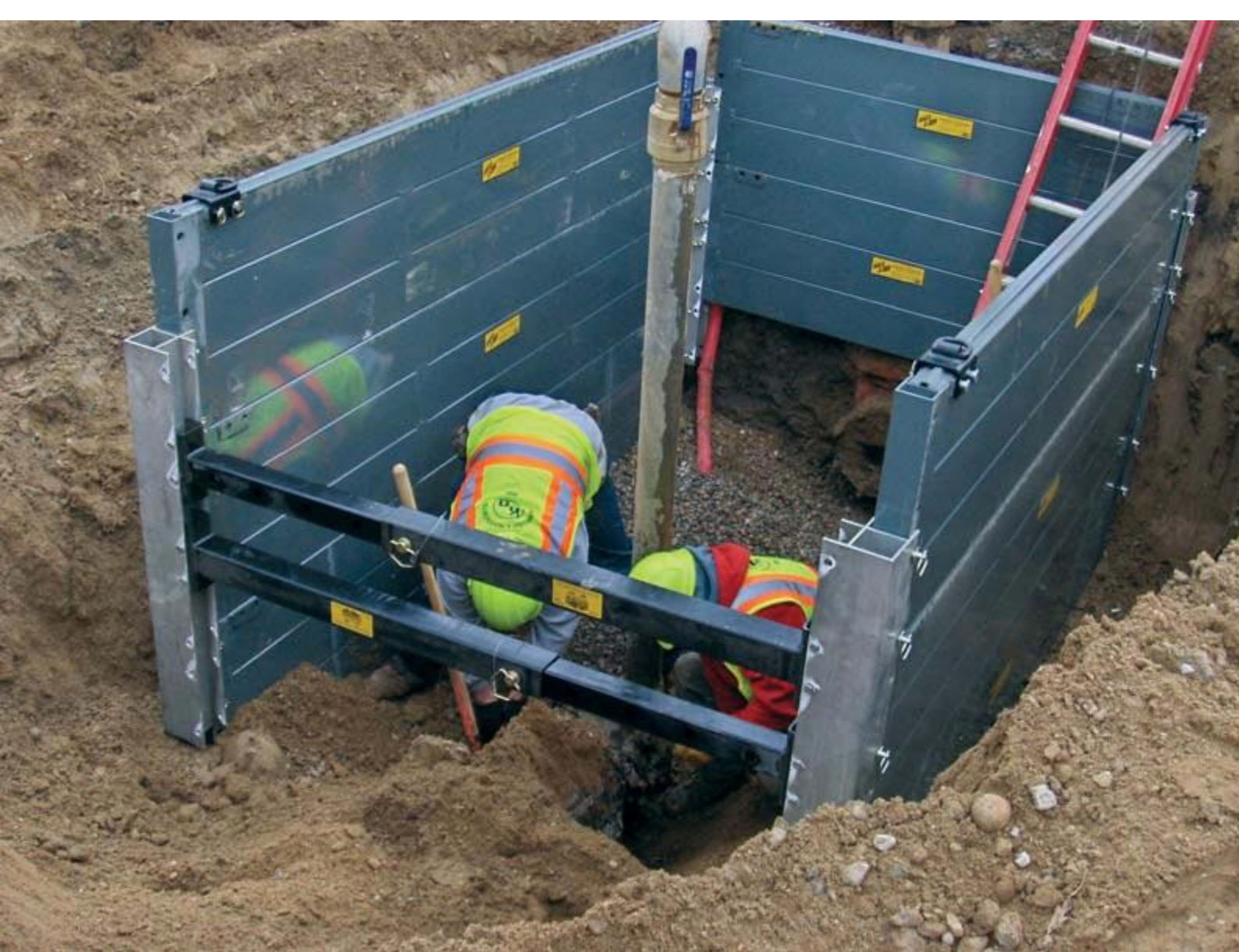
What are some safety guidelines in trenching?





Trench sloping





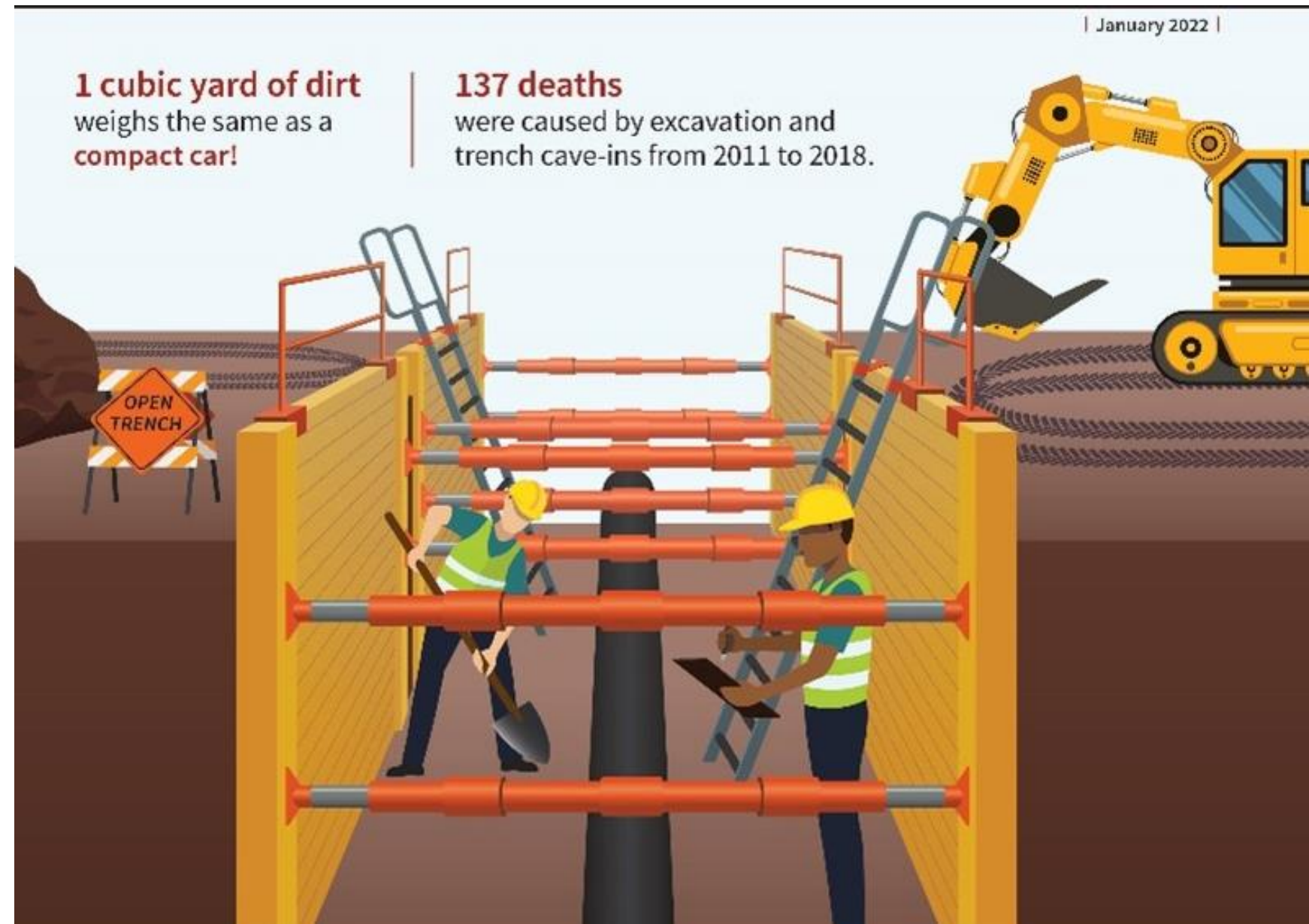
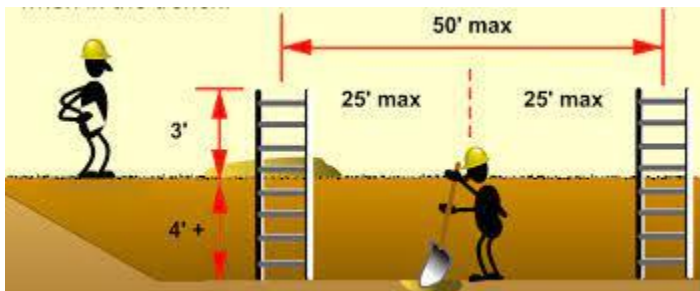
Trench shielding



Hydraulic Shoring

Trench shoring

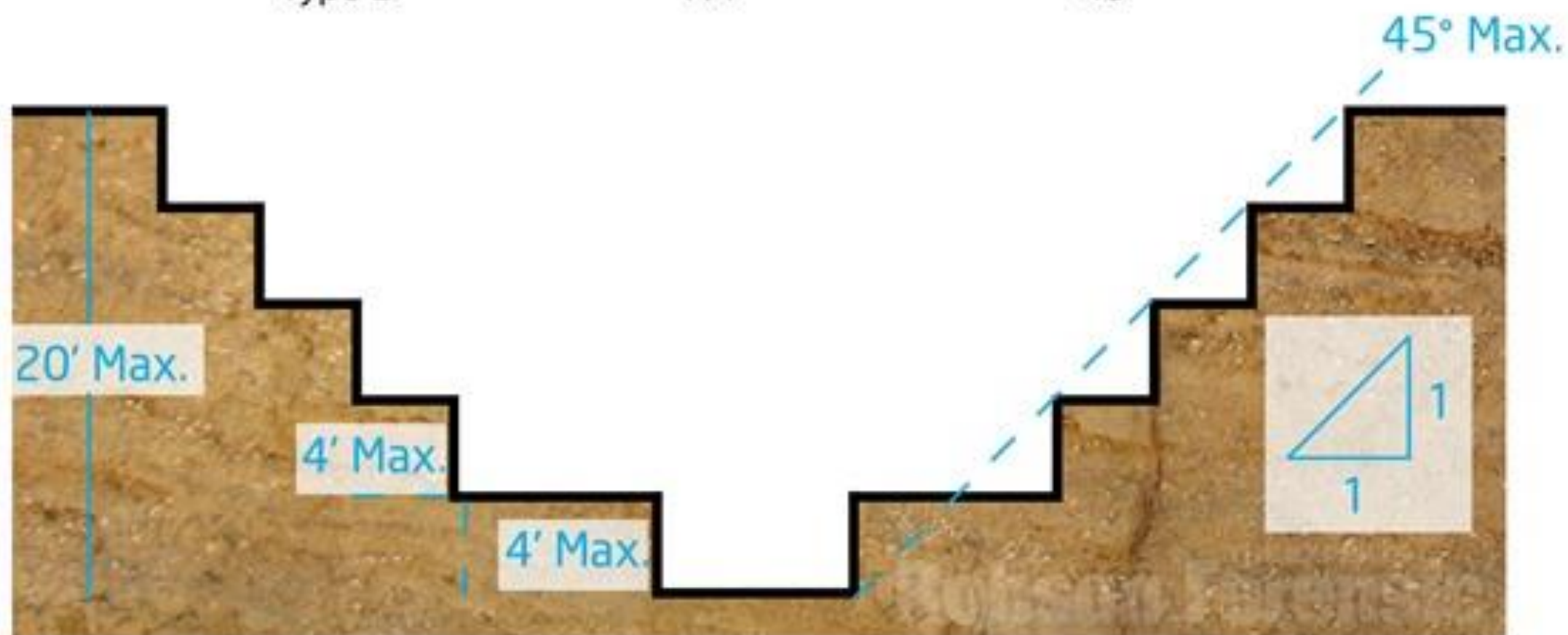
Trench Safe Access and Egress for safety



Depiction of Benching

Benching Slope Varies by Soil Type

Soil Type	Max. Slope (H:V)	Slope Angle (degrees)
Type A	3/4 : 1	53
Type B	1 : 1	45



How can I prevent machinery accidents? *(slide 1 of 2)*

Inspect Machinery Regularly

- Schedule routine machinery inspections to detect and address potential faults or defects promptly.

Train Operators

- Provide comprehensive training for machinery operators, ensuring they are proficient in safe operation and maintenance procedures.

Use Safety Guards

- Install and maintain appropriate safety guards and shields on machinery to prevent contact with moving parts.

Conduct Pre-Operational Checks

- Prior to use, require operators to conduct pre-operational checks to confirm that machinery functions correctly.

Follow Lockout/Tagout Procedures

- Implement lockout/tagout procedures when performing maintenance or repairs to prevent unexpected energization of machinery.

Maintain Clear Visibility

- Ensure machinery operators have unobstructed visibility, and use backup alarms and spotter personnel when necessary.

Establish No-Go Zones

- Define and enforce designated no-go zones to keep workers at a safe distance from operating machinery.

How can I prevent machinery accidents? *(slide 2 of 2)*

Provide Adequate Lighting

- Ensure proper lighting in and around machinery areas to enhance visibility and safety.

Avoid Overloading

- Adhere to load limits and avoid overloading machinery to maintain stability and prevent accidents.

Secure Loads

- Safely secure loads on equipment like cranes and forklifts to prevent shifting or falling during transport.

Control Speed

- Implement speed limits and safe operating speeds for machinery to reduce the risk of collisions or rollovers.

Stay Clear of Moving Parts

- Instruct workers to stay clear of machinery while it's in operation and never reach into moving equipment.

Properly Park and Secure Equipment

- Ensure machinery is properly parked and securely immobilized when not in use to prevent unintended movement.

How can I prevent equipment rollovers?



1. **Train Operators:** Provide comprehensive training for equipment operators, ensuring they are skilled in safe equipment operation techniques.
2. **Check Load Limits:** Verify that loads are within the specified weight limits for equipment to maintain stability.
3. **Use Load Charts:** Refer to load charts and equipment manufacturer guidelines to determine safe load capacities.
4. **Monitor Ground Conditions:** Continuously assess ground conditions to identify potential hazards like soft or uneven terrain.
5. **Avoid Overloading:** Prevent overloading equipment by adhering to load limits and distributing loads evenly.
6. **Secure Loads:** Properly secure loads with straps, chains, or other suitable restraints to prevent shifting during transport or operation.
7. **Inspect Tires:** Regularly inspect tires for proper inflation, tread wear, and damage, addressing any issues immediately.
8. **Operate on Level Ground:** Use equipment on level and stable surfaces whenever possible to maintain balance.
9. **Slow Down on Slopes:** Reduce speed and exercise caution when operating equipment on slopes or uneven terrain.
10. **Implement Rollover Protection:** Equip equipment with rollover protection systems (ROPS) and seat belts to safeguard operators in the event of a rollover.

How can I prevent hazards due to working in confined spaces (other than tranches)? *(Slide 2 of 2)*

Identify Confined Spaces

Clearly define what constitutes a confined space at your construction site. Confined spaces can include tanks, sewers, manholes, silos, vaults, tunnels, and more.

Conduct a Risk Assessment

Before any work begins, conduct a thorough risk assessment to identify potential hazards specific to the confined space. This assessment should consider factors such as atmospheric conditions, potential for engulfment, and hazardous substances.

Train Workers

Ensure that all workers involved in confined space work receive appropriate training on confined space hazards, safe work practices, and emergency procedures. Workers should know how to use safety equipment and be trained in first aid and CPR.

Use Proper Entry Permits

Implement a confined space entry permit system. Workers should obtain a permit before entering a confined space, and permits should only be issued after a thorough evaluation of safety conditions.

Ventilation

Ensure adequate ventilation within the confined space to control atmospheric hazards. This may involve using fans, blowers, or natural ventilation methods.

Atmospheric Testing

Regularly test and monitor the atmosphere inside the confined space for oxygen levels, flammable gases, and toxic substances. Ensure that workers have access to gas detectors and that they are trained to interpret the readings.

Isolation and Lockout/Tagout

Isolate and lockout/tagout all energy sources associated with the confined space to prevent accidental activation of equipment or machinery.

Proper Equipment

Provide workers with appropriate personal protective equipment (PPE), including respiratory protection, fall protection, and gas detectors. Ensure that PPE is in good working condition and used correctly.

How can I prevent hazards due to working in confined spaces (other than tranches)? *(Slide 1 of 2)*

Emergency Procedures

Establish and communicate clear emergency procedures, including rescue plans. Have rescue equipment on hand, and train a designated rescue team in confined space rescue techniques.

Communication

Maintain constant communication with workers inside the confined space using two-way radios or other reliable communication devices.

Safe Entry and Exit

Ensure safe means of entry and exit from the confined space, such as properly positioned ladders, stairs, or hoists. These should be regularly inspected for safety.

Supervision

Assign a competent person to supervise confined space work. This person should have knowledge of confined space hazards and emergency procedures.

Regular Inspections

Conduct regular inspections of confined spaces, including before and after entry, to ensure safety conditions are maintained.

Record Keeping

Maintain records of confined space entry permits, atmospheric testing results, training records, and any incidents or near misses. These records can help identify trends and areas for improvement.

Continuous Training and Evaluation

Regularly update and reinforce safety training, procedures, and equipment. Conduct debriefings after confined space work to evaluate what went well and identify areas for improvement.

Review and Revise Procedures

Periodically review and update confined space procedures based on lessons learned and changes in regulations or technology.